A METHOD AND A DEVICE FOR COMMUNICATION AMONG EQUAL-ACCESS ~~STATIONS OF A RING-SHAPED, SERIAL FIBER-OPTIC BUS~~

Field of The Invention

The present invention relates to a method for communication among equal-access stations of a ring-shaped, serial fiber-optic bus and a device for carrying out this communications method.

Background Information

5 A serial bus system is known for networking "intelligent" input/output units as well as sensors and actuators within an installation or machine. This serial bus system is called Controller Area Network (CAN) and is currently used not only in automobiles but also in industrial automation, for example

10 in textile machines, packing machines, machines for manufacturing and distributing paper, and in medical technology. The serial bus is composed of a two-wire line, each of whose ends is provided with a bus terminal resistor.

15 CAN is a serial bus system that is multi-master capable, i.e., a plurality of CAN nodes can simultaneously request the bus. In CAN data transmission, according to the publication "Controller Area Network -- a Serial Bus System Not Only for Motor Vehicles" of the International Association "CAN in

20 Automation (CiA) e.V.," no stations on the bus are addressed, but rather the content of the message is designated by a network-wide unambiguous identifier. In addition to recognizing the contents, the identifier also establishes the priorities of the message. The priorities are issued in the

25 system design through corresponding binary values and are not dynamically changeable. The identifier having the lowest binary number has the highest priority. Conflict in bus access is resolved using bit-by-bit arbitration regarding the respective identifiers, in that each station, bit for bit,

30 observes the bus level. In this competition among stations, all of the "losers" automatically become receivers of the message having the highest priority and only make the attempt

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once again to transmit when the bus becomes free. Upon the
acceptance check occurring ~~then,~~ all receiver stations in the
CAN network, after correctly receiving the message based on
the identifier, determine whether the data received are

5   relevant for it or not (selecting). If the data have meaning
for the receiver stations, then they are further processed
(acceptance), but otherwise they are simply ignored. The
length of the information to be transmitted is relatively
short. Eight bytes of useful data can be transmitted per

10   message. Longer data blocks can be transmitted through
segmenting. The maximum transmission speed is 1 MBit/s. This
value applies to a bus system having an extension of up to 40
m. For distances up to 500 m, a transmission speed of 125
kBit/s is possible, and at transmission lengths of up to 1 km,

15   a value of only 50 kBit/s is permissible. The number of users
in one CAN bus system is theoretically limited by the number
of available identifiers (2032 in standard format and $0.5 \cdot 10^9$
in expanded format). Therefore, CAN permits the realization of
need-dependent bus access, proceeding, on the basis of the

20   bit-by-bit arbitration, in a non-destructive manner through
message priority. A synchronization mechanism is not supported
by the CAN and the data transmission speed is too low for a
process in which a plurality of sequences of motions proceed
synchronously, one after the other.

25   *One*

A digital serial field bus system that supports a
synchronization mechanism is the SERCOS interface (Serial
Real Time Communication System). This SERCOS interface is a
digital, serial communications system between control units

30   and drive systems or input/output modules, and it is presented
in greater detail in the article, "Communication in Drive
Systems," by Berthold Gick, Peter Mutschler, and Stephan
Schultze, published in the German publication "etz", Vol. 112
(1991), Issue 17, pp. 906-916.

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A SERCOS interface specifies a rigidly hierarchical
communication having data in the form of data blocks, the so-

called messages, which are exchanged in temporally constant cycles between a control unit and a plurality of substations. Direct communication between the substations does not take place. The SERCOS interface makes use of the ring topology,

5   there being present as users for each ring a control unit, also termed master, and a plurality of substations, also termed slaves. The physical layer of a transmission link is composed of optical point-to-point connections. The optical transmission takes place in a directed manner, the elements of

10   the transmission link being electro-optical converters, fiber optics, and opto-electrical converters. The transmission rate is 2 MBit/s, 4 MBit/s, or 8 MBit/s. The length of each transmission segment in plastic optical fibers can be as much as 60 m, and in the glass optical fiber up to 250 m. The

15   maximum number of users for each fiber-optic ring is 254. In addition, repeat amplifiers are arranged in the slaves so that signal distortions arising as a result of the optical transmission cannot accumulate. The active signal conditioning and clock-pulse regeneration is achieved with the assistance

20   of phase-locking loops. By using fillers and bit stuffing, it is assured that a sufficient quantity of signal edges is contained in the data stream. As a result, it is made possible for the phase-locking loops always to remain "locked in place," i.e., bit-synchronous.

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       Communication in the SERCOS interface is cyclical in operation, in the form of a master-slave communication having a cycle time that is selected during initialization. The master, in an independent transmitter signal element timing,

30   either transmits messages or supplies filler to the ring. The slaves relay either their re-generated input signals to the next users (repeater function), or they transmit their own message. The master does not relay its input signal. For this reason, direct lateral (internode) communication between the

35   individual slaves is not possible, and the ring can therefore be viewed as open at the master.

Each message begins and ends with a message boundary and has an address field, a data field, and a check sum. Messages that are transmitted by the slaves are source-addressed, i.e., ~~here,~~ the content of the address field indicates the transmitting station. Messages that the master transmits are destination-addressed. In the data field are the data to be transmitted. The length of the individual data fields of different messages is fixed during initialization and is then maintained at a constant value.

The communications cycle of the SERCOS interface is subdivided into five phases. The cycle begins with a master synchronization message, which functions to stipulate (input) the communications phase and the time reference. This is followed by the drive messages (source-addressed), which are transmitted by the individual slaves. After all the drive messages are present at the master, it transmits to all slaves a master data message. In addition, each slave, from the initialization time points, knows T3 and T4 within one cycle. At time point T3, system-wide, all data (setpoint values) are simultaneously released, and at time point T4, system-wide, all measuring values are simultaneously scanned. Immediately after the conclusion of the cycle time, the master begins the next cycle with the master synchronization message. Therefore, a SERCOS interface has the following synchronization types: bit synchronicity, synchronization of the communication, and the synchronization of data processing in the slaves.

Using this SERCOS interface, no rapid, direct-access communication that is also simple can be carried out among equal-access stations.

In the article, "How 'Peer-To-Peer' Aids Drive Technology," published in the German publication "Engineering and Automation," Vol. 16 (1994), Nos. 3-4, p. 48, a possibility is presented in which, within one multi-motor interconnection, signals are transmitted from drive unit to drive unit. Peer-

to-peer connection denotes "connection between equal-access partners." In this peer-to-peer connection, one and the same drive unit can be both master (setpoint value source) as well as slave (setpoint value acceptor). The peer-to-peer

5 connection for each drive unit is composed of a receiving and a transmitting connection and of a two-wire line. On the basis of a peer-to-peer connection, an autonomous setpoint value cascade can be constructed, which is simple to configure and to place in operation. The transmission rate is up to 187.5

10 kBit/s, and it can be increased to up to 16 control signals. In this peer-to-peer connection, the expense for constructing a new communications sequence is quite high, since new two-wire lines must be laid.

Summary

15 ~~The invention is based on the objective of indicating~~ a method for communication among equal-access stations of a ring-shaped, serial fiber-optic bus, in which the aforementioned disadvantages no longer obtain.

20 ~~This objective is achieved according to the present invention in the features of Claim 1.~~

In *the* communications method according to the present invention, from the equal-access stations on the ring-shaped,

25 serial fiber-optic bus, one station is parametrized as the dispatcher and the other stations as transceivers. The dispatcher station, during each bus cycle, generates strictly time-cyclical container messages, addresses them, and supplies them to the bus. As the end message of each single bus cycle,

30 this dispatcher station transmits a synchronization message. Each transceiver station writes its data into the container message addressed to it. Therefore, these written-in container messages are source-addressed. In addition, each transceiver station, as a function of its read authorization, can read the

35 data of the written-in container messages on the serial bus. From the synchronization message that has been read, each station on the bus generates an interrupt, which, as a

function of the position of the stations, is time-delayed on the bus such that all interrupts are output time-synchronously. Upon the output of these interrupts, all data that have been read are further processed.

As result of the fact that, during each bus cycle, sequentially arranged messages are provided to the bus, a bit stream is always present on the bus, so that the stations on the bus are operated in a bit-oriented manner. The time between two synchronization messages is the bus cycle time of the ring-shaped, serial fiber-optic bus and, at the same time, corresponds to the common system clock for the synchronization of all connected stations. This synchronization message is generated so as to be ~~strictly~~ time-equidistant and jitter-free. Therefore, one of the equal-access stations also functions as the clock generator, and the other stations file their data, in each case, in the container messages assigned to them and thus make available their data for reading to all other stations on the serial bus. Since each station, as result of parametrizing, knows which source-addressed data may be read, every direct-access communication among equal-access stations, as result of parametrizing, can be set up without having to modify the hardware of the fiber-optic bus. In order that the communication on the ring-shaped, serial fiber-optic bus be maintained, one station must take on the function of the clock generator. Otherwise, no other means are required which control the communication among the equal-access stations on this bus.

~~Advantageous refinements of the communications method and of the device for carrying out this communications method can be found in the subclaims.~~

~~For a more detailed explanation of the invention, reference is made to the drawing, in which one specific embodiment of a device for carrying out the method according to the present invention for communication among equal-access stations is~~

Brief Description of the Drawings

Figure 1	depicts a bus topology.
Figure 2	depicts in greater detail a block diagram of an interface assembly of the bus system according to the present invention.
Figure 3	depicts the "write" addressing mechanism, whereas
Figure 4	represents the "read" addressing mechanism.
Figure 5	depicts a configuration example for a peer-to-peer functionality.
Figure 6	depicts the appropriate communications table of the configuration example according to Figure 5; and
Figures 7-10	illustrate the different addressing mechanisms of the configuration example.

Detailed Descriptions

In Figure 1, a bus topology is represented, on the basis of which a plurality of equal-access stations 2 through 12 can communicate with each other. Individual stations 2 through 12 are each connected one to another using an optical fiber 14 as transmission medium. The data direction on this ring-shaped, serial fiber-optic bus is directionally determined and is illustrated by arrow D. As transmission medium, glass optical fibers or plastic optical fibers can be used. In order for the method according to the present invention for communication among equal-access stations 2 through 12 of a ring-shaped, serial fiber-optic bus to be carried out, one station 2 is parametrized as dispatcher and other stations 4 through 12 as transceivers. Each station 2 through 12 on the fiber-optic bus acts as a signal amplifier. Therefore, when plastic optical fibers are used as the transmission medium, a maximum of 40 m, and when glass optical fibers are used as the transmission medium a maximum of 300 m can be the distance between stations 2 through 12. The maximum number of users on the ring-shaped, serial fiber-optic bus is 201 in the example embodiment.

Dispatcher station 2 has the function of feeder and is the
clock generator of this bus system. The communications
controller is stored as a task table in a read-
write memory 16 of dispatcher station 2. In this task table,
the number of messages this dispatcher station 2
has to send, in one bus cycle, also designated as bus cycle
time is determined. For this purpose, for every active user, i.e., equal-
access stations 2 through 12 on the serial bus, there are
determined in this task table, inter alia, an address and a
channel number as subaddress. In addition, the addresses of
so-called blank messages and of special messages are also
stored in this task table. Among these special messages are,
inter alia, the synchronization message and the so-called NOP
messages (No operation). On the basis of the synchronization
message, all stations 2 through 12 of this ring-shaped bus are
requested to further process the data that have been read. The
blank messages and the NOP messages function as filler
messages, so that within each bus cycle time, messages are
continuously circulating on the ring-shaped, serial fiber-
optic bus. In this manner, stations 2 through 12 are operated
on the bus in a bit-synchronous manner. The synchronization
message is always the last entry in the task table and is
therefore always transmitted at the end of the bus cycle time.
The task table is limited to a maximum of 1024 entries, i.e.,
a maximum of 1024 messages can be transmitted in one bus cycle
from dispatcher station 2. For each user, eight subaddresses
can be used. If, therefore, for all the active users of the
ring-shaped, serial fiber-optic bus all eight subaddresses are
used, then a maximum of 128 users can be connected to the bus.

Dispatcher station 2 executes its task table, by linking, in
transmission sequence, every address to a container message
and outputting it to the serial bus. After the last entry of
this task table has been read out, the processing of the
entries of this task table is begun from the beginning,
without delay. The container messages are generated in a
strictly time-cyclical manner. Each transceiver station 4

through 12 receives the messages initiated by dispatcher
station 2 and can read the data of the messages, in accordance
with its read authorization, and can overwrite using its own
data, or store them. Dispatcher station 2, just as each

5   transceiver station 4 through 12, can read the data of the
messages, in accordance with its read authorization, and can
overwrite using its own data, or store them. In addition, each
transceiver station 4 through 12 relays the received messages
regardless of whether the data have been read or have been

10   overwritten using new data, or have been stored in them. No
stations 2 through 12 on the ring-shaped, serial fiber-optic
bus which are parametrized as transceivers can autonomously
maintain the data traffic on the ring bus. This is exclusively
the task of dispatcher station 2.

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In Figure 2, a block diagram is schematically depicted of an
example
^interface module 18, which is arranged in each station 2
through 12 of the ring bus in accordance with Figure 1. This
interface module 18 has a programmable microchip 20 having an

20   associated erasable read-only memory 22, a read-write memory
16, a clock generator 24, a system connector 26, an opto-
electrical and an electro-optical converter 28 and 30, and a
voltage source 32. In addition, a front side 34 of this
interface module 18 is provided with a plurality of light-

25   emitting diodes 36, 38, and 40 for the status display of this
interface module 18, two fiber-optic connector sockets 42 and
44, which are also designated as bus connector sockets 42 and
44, and a current source connector socket 46. Bus connector
socket 42 or 44 receives an optical fiber 14 of the serial

30   ring bus and is linked to opto-electrical or electro-optical
converter 28 or 30. This converter 28 or 30 is connected in an
electrically conductive manner, on the output or the input
side, to a terminal of programmable microchip 20. Similarly,
erasable read-only memory 22, read-write memory 16, and clock

35   generator 24 are also linked to this programmable microchip
20. As voltage source 32, a DC/DC voltage transformer is
provided, which transforms an external DC voltage of, for

example, 24 V into an internal DC voltage U_v of, for example, 5 V. It can also be seen from this representation that this DC voltage U_v is also supplied by one station 2 through 12, to which this interface module 18 is plugged in. The exchange of

5   signals S_A (addresses), S_D (data), and S_C (control signals, interrupts), as well as of DC voltage U_v is brought about using system connector 26.

If, for example, voltage U_v of one of stations 2 through 12

10   fails, the performance capacity of interface module 18 and thus the performance capacity of the ring-shaped, serial fiber-optic bus can be maintained by an external voltage source connected to interface module 18. Programmable microchip 20 has a device 48 for parametrizing interface

15   module 18 as dispatcher or as transceiver. As programmable microchip 20, a programmable gate array is provided, in particular a Field-Programmable Gate Array (FPGA), whose program is stored in erasable read-only memory 22. For executing this program, a clock pulse is required which is

20   supplied by clock generator 24, in particular an oscillator. In read-write memory 16, either a task table or transmitting and receiving data are stored.

If this interface module 18 is parametrized as dispatcher

25   using device 48, then a task table must be created in read-write memory 16. If this interface module 18 is parametrized as transceiver using device 48, then in read-write memory 16 transmitting and receiving data are stored during a bus cycle. In this read-write memory 16, the addresses of messages are

30   stored which are to be read by this interface module 18.

As was already mentioned, front side 34 of interface module 18 has three light-emitting diodes 36, 38, and 40, which give information concerning the current operating state. If light-

35   emitting diode 36 flashes, ~~which is~~, for example, green, then error-free useful-data traffic is taking place across the ring-shaped, serial fiber-optic bus. If light-emitting diode

38 flashes, ~~which is~~, for example, red, then interface module
18 is in operation. If light-emitting diode 40, flashes, ~~which~~
~~is~~, for example, yellow, then the data exchange is functioning
properly between this interface module 18 and the station to

5   which this interface module 18 is plugged in. If one of these
light-emitting diodes 36, 38, and 40 is inactive, then a fault
is present.

Both converters 28 and 30, together with one part of
10   programmable microchip 20, constitute a so-called interface
circuit 50 of interface module 18. This interface circuit 50
is the interface of each interface module 18 to the ring bus.
The function of this interface circuit 50 lies in converting
the received message into electrical signals, scanning and
15   regenerating the signals, as well as subsequently converting
the electrical signal into a transmission message. Each
interface circuit 50 influences to the same degree the time
response (dynamic behavior) of the data transmission. _That is_, ~~i.e.~~,
each received message is delayed by roughly 3 bit-times before
20   it can again be transmitted on the bus. This delay is also
termed processing (transmission) delay. This delay is caused,
on the one hand, by converters 28 and 30 and, on the other
hand, by the signal scanning and regeneration. At a fixed data
transmission rate of, for example, 11 MBit/s, the 3 bit- times
25   correspond to a time of 272 ns.

In Figure 3, the "write" addressing mechanism is illustrated.
In this illustration, only one part of read-write memory 16 of
interface module 18 is depicted. Dispatcher station 2 and each
30   transceiver station 4 through 12 may write data only in
container messages, which are assigned to them at their
address. Each message CT, in the message heading, has an
address AH and a channel number as subaddress AS. Each address
AH has eight subaddresses, which are each 32 bits large.
35   Therefore, each station 2 through 12 can transmit a maximum of
8 x 32 bit-data in eight messages CT, which have the same
addresses AH and channel numbers of 0 through 7 as

subaddresses AS.

In the depicted example of Figure 3, the user on the ring bus having address 5, i.e., this user is a transceiver station 4 through 12, writes data from subaddress 0 into container message CT having address 5. If data are already stored in data field DF of this message 5/0, then they are overwritten in this write mechanism. The data written into data field DF of this container message CT have been written by the associated transceiver station into this read-write memory 16 using signals S_A and S_D via system connector 26 and programmable microchip 20. Therefore, this part of read-write memory 16 constitutes a transmission memory, in which process data such as setpoint values, actual values, control or status information are written. In the communications method according to the present invention, each station can write data into its associated container message CT. Therefore, each message CT is not destination-addressed, but rather source-addressed. In this manner, the communication among equal-access stations 2 through 12 on the serial ring bus is made simpler because each station 2 through 12, with respect to the transmission of a message CT, i.e., the writing of data, stores data only in container messages CT that bear its address.

In Figure 4, the "write" addressing mechanism is illustrated. In this illustration, just as in the illustration according to Figure 3, only one part of read-write memory 16 of interface module 18 is depicted. Dispatcher station 2 and each transceiver station 4 through 12, in direct-access, can read the data from every message CT on the ring bus (including their own messages). Which messages CT can ultimately be read, depends in each case on the read authorization of each station 2 through 12 of the serial ring bus, as parametrized in the initialization of an application. For this purpose, in dispatcher station 2 or in transceiver stations 4 through 12, addresses AH and subaddresses AS are, in each case,

parametrized as a receiving message, whose data are to be read.

In the example depicted in Figure 4, the user on the ring bus having address 5 reads data from data field DF of container message CT having address 5/3, i.e., this user writes the data into the data channel having channel number 3 of one part of read-write memory 16. This part of read-write memory 16 is therefore designated as the receiving memory. In order that this user having address 5 can read container message CT having address 6/3, this address 6/3 must be configured as a read address. It can be seen from this illustration that a further part of this read-write memory 16 is provided for the configuration of the read authorization of associated interface module 18. In this part of read-write memory 16 are entered the addresses of all messages CT to be read having address AH and subaddress AS.

Upon the transmission of the final entry in the task table, i.e., the synchronization message, in each station 2 through 12 of the ring bus, delay times for compensating for the running time delay, created by the signal transformation in each user, are compensated for in a time-delayed manner. For this calculation of an individual time delay, each station 2 through 12 knows the number of equal-access stations 2 through 12 on the ring bus and their associated location numbers. Upon the termination of each calculated time delay, in each case, an interrupt is available, by which stations 2 through 12 are time-synchronized. Using this interrupt, the data that have been read are imported from the receiving memory of read-write memory 16 of each interface module 18 into the respective associated station. Internal closed-loop control circuits of individual stations 2 through 12 on the serial ring bus can be synchronized to this strictly time-cyclical synchronization message.

On the basis of a configuration example for a peer-to-peer

functionality in accordance with Figures 5 through 10, the
method according to the present invention for communication
among equal-access stations 2 through 14 of a ring-shaped,
serial fiber-optic bus is explained in greater detail:

In the configuration example, three converter-fed motors, at a
precise angle, are to run in a synchronized manner. Thus, on
one ring-shaped, serial fiber-optic bus, three stations 2, 4,
and 6 are connected with the assistance of their associated
interface modules 18. Each station 2, 4, and 6 constitutes a
variable-speed drive composed of a converter 52 and an AC
motor 54. Interface modules 18 of three stations 2, 4, and 6
of the ring bus are connected to each other by optical fibers
4 such that station 2 has location number 1, station 4
location number 2, and station 6 location number 3. Each
interface module 18 has communicated to it its location number
and the number of stations 2, 4, and 6 on the serial ring bus.
From these numbers, each interface module 18 calculates its
individual delay time.

In this angle-precise, synchro control of three variable-speed
drives, station 2 is declared as leading drive having an
integrated virtual leading axis. The speed reference input
variable for this interface module is prescribed through an
analog entry or a system control unit.

The integrated virtual leading axis function generates a path,
speed, and acceleration setpoint value, S_{soll}, n_{soll}, and a_{soll} for
stations 4 and 6, which constitute a following drive 2 and a
following drive 3. In this configuration example, following
drives 2 and 3 are also to be switched on and off by the
leading drive. This means that each following drive receives
an individual control word, STW.2 or STW.3. Conversely, the
following drive is to transmit an individual status word, ZW.2
or ZW.3, to the leading drive. This results in a
communications table, which is depicted in greater detail in
Figure 6

For the transmission of process data, interface modules 18 of the three stations 2, 4, and 6 must be parametrized as follows:

5   Interface module 18 in dispatcher station 2
(leading drive)
The following five process data must be transmitted:
- STW.2 = control word for station 4
- STW.3 = control word for station 6
10   - s_{soll} = path setpoint value
- n_{soll} = speed setpoint value
- a_{soll} = acceleration setpoint value
Five messages, i.e., five channels, are required for this purpose.

15

Interface module 18 of transceiver station 4
(following drive 2)
A process datum is transmitted in status word ZW.2
(write).
20   For this purpose, one message (= one channel) is required.
ZW.2 = status word from station 4

Interface module 18 of transceiver station 6
(following drive 3)
25   A process datum is transmitted in status word ZW.3
(write).
For this purpose, one message (= one channel) is required.
ZW.3 = status word from station 6.

30   For dispatcher station 2 as leading drive, the following parameter settings are significant:

Device 48 on interface module 18 of dispatcher station 2 is set at dispatcher. Thereupon, the channel number, which, in
35   this configuration example, is 5, is communicated to interface module 18 of dispatcher station 2. Therefore, each user has available to it five messages for writing. Subsequently, the

cycle time is entered as a parameter, which in this example is
1 ms. Since this cycle time cannot be reached on the basis of
five messages, as many additional messages, so-called blank
messages and NOP messages, are transmitted automatically until
5   this cycle time is reached.

For the synchronization of the decentralized, lower-level
closed-loop control circuits in converters 52 of stations 2,
4, and 6, the bus cycle time must have a defined relationship
10   with respect to the time slices of the individual closed-loop
controllers. For the time slices of converter 52, the
following determination applies:
- current control in time slice T_0
- speed control in time slice $2 \cdot T_0$
15   - position control in time slice $4 \cdot T_0$

Time slice T_0 is equal to the reciprocal value of the pulse
frequency and is set in converter 52 by the selection of pulse
frequency. Then, for the selection of the bus cycle time, the
20   following applies:

Bus cycle time = n x the slowest time slice to be synchronized
where n = 1, 2, 3 ...

25   In the configuration example, the position control loops of
three stations 2, 4, and 8 are to be synchronized, as a result
of which the bus cycle time is selected such that n times the
time slice of the position control corresponds to it. At the
conclusion of the parametrizing, transceiver station 2
30   (following drive 2) receives user address 1, and transceiver
station 6 (following drive 3) receives user address 2.

In Figure 7, the "read" addressing mechanism of station 2 is
illustrated. Subscriber address 0 indicates that this
35   interface module 18 is parametrized as dispatcher. The data
that are located in subaddresses 0 through 4 are written onto
the bus one after the other using addresses 0/0 through 0/4

In Figure 8, the "write" addressing mechanism of station 4 is illustrated. User address 1 indicates that this interface module 18 is parametrized as transceiver. In addition, in one part of read-write memory 16, the read authorization of this

5   station 4 on the serial ring bus is stored in the form of a table. In this table are entered all message addresses, including their address AH and their subaddress AS, which are permitted to be read by this transceiver station 4. In reading these messages CT, the data, here acceleration setpoint value

10   a_{soll}, of data field DF of container message CT are copied, in accordance with subaddress AS, into the corresponding data channel of the receiving memory of read-write memory 16. A comparison with container messages CT of dispatcher station 2 in accordance with Figure 7 indicates that the message having

15   address 0/1 may not be read by transceiver station 4, i.e., this message having address 0/1 is transmitted only with the assistance of interface circuit 50 of this interface module 18 to the next user of this serial ring bus.

20   In Figure 9, the "write" addressing mechanism of transceiver station 4 is depicted. In accordance therewith, this transceiver station 4, in a container message CT having address 1/0 of this transceiver station 4, writes its data, here status word ZW.2 of following drive 2, into corresponding

25   data field DF. If this transceiver station 4 has to transmit up to eight data to the ring bus, dispatcher station 2, in accordance with a task table, would transmit a further seven container messages CT having user addresses 1/1-1/7, sequentially arranged on the ring bus.

30

Since the data (status word) of transceiver stations 4 and 6 (following drives 2 and 3) are to be transmitted to dispatcher station 2 (leading drive), this dispatcher station 2 must have a corresponding read authorization. That is, in a read

35   authorization table of read-write memory 16 of interface module 18, the message addresses of stations 4 and 6 on the serial ring bus are entered, whose messages CT dispatcher

station 2 is to read. Since the data of transceiver stations 4 and 6, in each case, are located in the first subaddress, user addresses 1/0 and 2/0 are stored in the read authorization table of dispatcher station 2.

In the initialization of this configuration example, in addition to the parameters of number of users, location number, and dispatcher or transceiver function, further parameter settings must be undertaken. Since this ring-shaped, serial fiber-optic bus has a constant transfer rate of, for example, 11 MBit/s and an overall length of each message CT is 70 bits inclusive of the 32 bits of data, therefore one message CT requires a transfer time of 6.36 μs. A bus cycle time is determined as a function of the time slices of the individual closed-loop control circuits of the users connected on the ring bus. It is assumed that in the configuration example, the bus cycle time is 1 ms. In addition, seven messages having user addresses 0/0 through 0/4, 1/0 and 2/0 and the synchronization message are transmitted. Since these eight messages do not reach the bus cycle time, as many additional messages, so-called blank messages, to non-address users are inserted until the cycle time of 1 ms is reached. Since the running time for one message is 70 bit-times, at a transfer rate of 11 MBit/s, 157 messages can be transmitted. These messages CT are transmitted without intervening pauses, one immediately after the other, as a result of which a strictly time-cyclical bus cycle is assured. If the bus cycle time is still not reached by the number of messages CT, the difference being smaller than the length of one message CT, then the temporal gap is filled with so-called NOP messages.

In this configuration example, the task table, which is stored in one part of read-write memory 16 of interface module 18 of dispatcher station 2, includes 157 messages, of which 7 are user messages having user addresses 0/0 through 0/4, 1/0, and 2/0, 159 are blank messages, and 1 is a synchronization message. These messages CT are listed in this sequence in the

task table. As a result of the synchronization message
transmitted at the end of the bus cycle time, in equal-access
stations 2, 4, and 6, individual time delays are calculated
such that at the same time in each station 2, 4, and 6, an
5   interrupt is generated which assures that, in each case, the
data that have been read from the receiving memory of read-
write memory 16 of each interface module 18 are imported from
corresponding converter 52 using signals S_A and S_D.

10   On the basis of this method according to the present invention
for communication among equal-access stations on a ring-
shaped, serial fiber-optic bus, process data can be exchanged
extremely rapidly, in a strictly time-cyclical manner among
the equal-access stations, each station communicating only
15   with the bus, due to the source addressing of the messages and
the direct-access read authorization. That is, each equal-access
station does not know the stations with which it communicates
but rather knows only which messages may be read and which may
be written in by it. In this manner, configuring a system is
20   reduced to parametrizing each equal-access station of a serial
bus system.

This communications method according to the present invention
can also be applied in a conventional hierarchical bus
25   structure. In a so-called master-slave bus structure, the
dispatcher station is the superordinate control unit, for
example, an automation system.